



BIOSCIENCE: CREATING ARIZONA'S FUTURE

2002 MARICOPA BIOINDUSTRY WORKFORCE SUMMIT

**A Meeting of the Maricopa Community Colleges
at Estrella Mountain Community College**

OCTOBER 11, 2002





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2002 Maricopa Bioindustry Workforce Summit EXECUTIVE SUMMARY

"A flourishing future in the biosciences hinges on the presence of a world-class research base. This is essential to compete with states that have well-developed programs and major funding commitments."

– Arizona's Bioscience Roadmap,

Highlights of the 2002 Battelle Arizona Study

An opportunity has presented itself to Arizonans. Since last year, bioindustry has become a hot topic and buzzword in the Greater Phoenix region, promising economic wealth and prosperity, a higher-waged, technology-driven employment base, and medical advancements for state residents. Of course, such accomplishments will not come without hard work, community support, collaborative efforts between business organizations and higher education, and strong leadership from key individuals. And so, with success, Arizona made a leap of faith and met the financial commitments necessary to lure the International Genomics Consortium (IGC) to Phoenix. This historic accomplishment led to the formation of the Translational Genomics Research Institute (TGen), and with both organizations serving as a principal foundation for numerous opportunities to build upon, Arizona is certain to leave a mark on the bioindustry map.

As a contributor to the success of these events, the Maricopa Community Colleges have pledged to provide a trained industry workforce, developing essential pipeline programs to encourage students to pursue math and science careers. In order to provide our colleges with sufficient background information and current happenings regarding bioindustry, the Center for Workforce Development and the Division of Academic Affairs decided to produce the 2002 Maricopa Bioindustry Workforce Summit. Hosted at the Center for Teaching and Learning on the campus of Estrella Mountain Community College, the Summit convened Maricopa faculty members, college and university administration, business and industry representatives, as well as representatives from Coconino Community College, Central Arizona College, Pima Community College, and Northland Pioneer College.

As a result of the rapidly evolving bioindustry and its impact on Arizona, several significant developments have occurred since the Summit's debut last October. However, in order to capture an accurate account of that day's activities, this document presents actual dialogue and discussion based on presentations given by our invited and distinguished guest speakers and panel members, whose expertise provided great insight into future opportunities that Maricopa should recognize.

The Center for Workforce Development is pleased to present the proceedings of this Summit and provide you with a summary of the catalyst event that initiated Maricopa's collaborative embark on bioindustry. We invite you to engage yourself and others in discussion of the facts, recommendations, and research found in the following pages. It is our hope that you use this document as a tool to inform and educate yourself about bioindustry and its anticipated effect on the growth and enhancement of Greater Phoenix and the Maricopa Community Colleges.



A VISION FOR THE FUTURE OF ARIZONA

"Now is an opportune time for Arizona to initiate bold action to ensure long-term prosperity for its citizens through a comprehensive partnership of its private and public sector leadership to build Arizona's future in selective fields of the biosciences ...Arizona's leaders are seeking to develop strengths in those technology areas expected to lead future economic growth — chief among them is the bioscience sector."

— Platform for Progress: Arizona's Bioscience Roadmap (2002)

In June 2002, Dr. Jeffrey Trent, a world-renowned genetics researcher formerly with the National Institute of Health, announced that he would be moving to Phoenix to head the International Genomics Consortium (IGC) and the Translational Genomics Research Institute (TGen), both of which will be established in a new 13-acre "research campus" in the heart of the city. These two nonprofit, biomedical research institutes will join the more than 50 biotechnology/bioscience companies (with 25 or more employees) already doing business in Arizona, 34 (or 64%) of which are located in Maricopa County.

To meet the projected employment needs of the rapidly growing bioindustry, catalyzed by the IGC's relocation to Phoenix, and the formation of TGen, the Maricopa Community Colleges have pledged to develop new district-wide educational and training programs, with support in part from \$1.5 million in Proposition 301 funds, dedicated to workforce development over the next five years. To initiate the design and enhancement of these programs, the Maricopa Community Colleges, under the leadership of Mary Vanis and the Center for Workforce Development, hosted a Bioindustry Workforce Summit at Estrella Mountain Community College, to discuss the future of bioindustry in Arizona, and to introduce the wealth of opportunities for educational and professional advancement for students of the Maricopa Community Colleges.

To set the stage for the summit, Dr. Vanis noted in her introductory remarks that the initial and primary focus of the biotechnology industry is research. In all related industries, from pharmaceutical to environmental, and from medical devices to agriculture, there is a pressing need not only for advanced researchers and management personnel but also for entry-level laboratory technicians, biologists and microbiologists, and production assistants to work as part of research teams. The news that both IGC and TGen will be located in Phoenix,

provides the Maricopa Community Colleges with an exciting new opportunity to plan for the future. But if the new institutes and related bioscience and biotechnology companies are to grow and make meaningful contributions to the Greater Phoenix economy, a skilled labor pool needs to be available. The Maricopa Community Colleges are in an ideal position to help meet both the immediate and long-term bioindustry labor requirements in Arizona, but only if they start planning for the future and developing and/or enhancing new and existing educational and training programs without delay.

Thus, first and foremost, the Bioindustry Workforce Summit was designed to serve as a catalyst for planning at the ten Maricopa Community Colleges and two skill centers. In her introduction, Dr. Vanis encouraged participating community college faculty and administrators to explore the economic and educational potential of this emerging industry. She also urged participants to identify the unique strengths of their individual campuses and student bodies, and once the summit concluded, to begin the process of developing individualized plans to help meet the employment and training needs of this new and rapidly growing industry in the state.

2002 BIOINDUSTRY WORKFORCE SUMMIT

Homero Lopez, President of Estrella Mountain Community College, stated in his welcoming remarks, that the workforce summit was designed primarily to discuss what role the Maricopa Community Colleges can and should play in the emerging biotechnology industry in the Greater Phoenix area. However, by its very nature, Dr. Lopez noted, the meeting was national in scope. Approximately 135 science and mathematics educators, community college administrators, leading researchers, and economic development and job training specialists were in attendance, including representatives from four colleges outside the Maricopa district. Speakers, too, represented a wide variety of interest and depth of experience, as they spoke on successful biotechnology programs at community colleges in California and Texas, as well as at Mesa Community College in Arizona.

Dr. Lopez also made a special point of highlighting the fact that approximately three-fourths of the attendees at the meeting were science, mathematics, and technology faculty. This strong showing from faculty was critical, he said, because it is ultimately these individuals who college administrators and



the biotechnology industry will rely on to introduce cutting edge techniques and approaches into existing courses, and to develop the new courses required to meet the needs of the growing bioscience and biotechnology industry in Arizona.

And, the timing for developing new courses and programs could not be better.

Fred Gaskin, Chancellor of the Maricopa Community Colleges, and one of the early supporters of developing a community college link to the bio-industry, explained how the State of Arizona, the City of Phoenix, local colleges and universities, and private companies have joined together to attract new industry, new startups, and new biotechnology-related jobs to the area.

In November 2000, voters approved Proposition 301 — a measure to raise the state sales tax by 0.6 percent to fund Arizona's education needs — boosting financial support for education by nearly \$460 million a year for 20 years. Three percent of the total revenue raised each year is to be used to fund community college workforce training programs in the state. By committing \$1.5 million in Proposition 301 funds over the next five years, Dr. Gaskin said the Maricopa Community Colleges will be able to develop the programs to train workers for this new priority industry. He noted that the Maricopa Community Colleges are actively engaged in program development for the biotechnology industry, and are developing high school pipeline programs, certificates, and degrees to encourage more culturally diverse students to pursue math and science careers.

Dr. Gaskin also noted that the Maricopa Community Colleges Governing Board, members of which were in attendance at the workforce summit, had pledged an additional \$1 million to the new Translational Genomics Research Institute (TGen). These funds will be used to support educational activities such as guest lecturers, faculty training, and student internships.

NEW SCIENCE IN A NEW RESEARCH ENVIRONMENT

The International Genomics Consortium (IGC) and the Translational Genomics Research Institute (TGen) are both nonprofit research institutes, dedicated to using bioscience and biotechnology to improve medical and other genetic research. Both will build on the work completed to date by the Human Genome Project, which has been sequencing the approximately three billion base pairs ("DNA letters") in human DNA and identifying all 30 to 40 thousand genes in human DNA. It is projected that the data derived from mapping the human genome will allow scientists to develop better diagnostics, treatments, and eventually cures for life threatening diseases such as cancer, diabetes, heart disease, hypertension, multiple sclerosis, obesity, and schizophrenia. Genetic information can also be used to uncover an individual's risk of developing a certain disease.

IGC is a national and international consortium that builds on the discoveries of the Human Genome Project and other systematic sequencing efforts by harnessing world-class genomic research,



bioinformatics, and diagnostic technologies to attack cancer and other complex genetic diseases. Now based in Phoenix, the IGC mission is to revolutionize the treatment and prevention of cancer and complex diseases by rigorously developing and applying post-genome science to advances in human health. Over the next three years, IGC will focus

on developing a genetic database of more than 10,000 cells from cancerous tumors and 1,000 normal samples, while also developing standards for analyzing the data. Once the database is complete, it is expected to be the largest of its kind yet available. It will then be made available through subscriptions to researchers and pharmaceutical companies, with the goal of providing the necessary genetic characteristics of tumors to enable specialized cancer treatments to be developed.

TGen is an independent, not-for-profit research institute with the mission to help "translate" scientific discoveries into diagnostics, treatments, and cures that improve the quality of life in Arizona and the rest of the nation. TGen researchers will collaborate with Arizona's three state universities and other independent research groups to create new uses for the data gathered by IGC and other research organizations and will also host community college faculty and student interns, with the goal of transferring new biotechnology research techniques and other workforce requirements. TGen researchers will also serve as guest faculty and lecturers, bringing the latest research findings to the community college classroom. TGen's director, Dr. Jeffrey Trent, previously headed the Human Genome Project for the National Institutes of Health.

Both research groups will be located in a new biomedical research campus in the heart of downtown Phoenix (see [City of Phoenix Biomedical Research Campus Site Map](#), page 4).



City of Phoenix Biomedical Research Campus
Site Map: *Both research groups will be located in a new biomedical research campus in the heart of downtown Phoenix.*

AN INVESTMENT IN THE FUTURE

Arizona is faced with a number of challenges, from changes in demographics to a lack of diversity in its economic base, according to Margie Emmermann, Director of the Arizona Department of Commerce. To address these challenges, Ms. Emmermann and her colleagues conducted a statewide economic study, looking for economic development opportunities in a variety of industries, from defense and aerospace industries to forest products. Ultimately, the Department of Commerce chose to focus their economic development activities and planning on industries with the greatest potential for long-term growth in Arizona: aerospace, environmental technology, information and communications technology, and biotechnology. As noted by Ms. Emmermann, the targeted areas have significant potential for the state, because they build on existing strengths, encourage entrepreneurship, create economic diversity, retain and attract “knowledge workers,” and if developed in the state, will increase per capita income and the tax base. Unlike tourism, she added, these industries have the potential to result in the development of new companies, thus, bringing greater economic diversity and stability to the area, along with higher paying jobs.

According to Sheryl Sculley, Assistant City Manager for the City of Phoenix, biotechnology is particularly important, because it is the fastest growing industry in the United States, doubling between 1993 and 1999, to \$47 billion. It’s also highly competitive, with growing government support for establishing academic bioscience research centers. For example, one of California’s three \$100 million institutes is in bioengineering and biotechnology, four of New York’s STAR (Strategically Targeted Academic Research) centers focus on biosciences, seven new or expanded health science research centers have been funded with an \$800 million appropriation in Texas, and a \$317 million BioStar initiative has been funded at the University of Wisconsin in Madison. If the state is to compete nationally, Arizona and the City of Phoenix need to make comparable commitments, she said.

And community colleges need to make commitments of their own, both speakers added. Ms. Emmermann and Ms. Sculley both noted that biotechnology can grow in the state, only if Arizona has a qualified workforce to meet the industry’s growing employment needs. As community college faculty and administrators continue to prepare their students for the future, programs must be developed to meet the emerging needs of this growing industry, they said. This is particularly important, because workforce availability is a company’s first concern when considering relocation. Therefore, it’s critical to have trained employees available, both for new companies just starting up in the area and for existing companies as they grow.

Fortunately, community colleges are uniquely positioned to meet these needs, they both agreed.

*...biotechnology
 is the fastest
 growing
 industry in the
 United States.*

For example, biotechnology/ bioscience requires a critical mass of qualified workers from healthcare technicians to lab analysts to computer programmers, but most of these jobs do not require an advanced degree to be performed successfully. In addition, bioindustry brings together what Ms. Emmermann

referred to as “technology convergence” (e.g., imaging, electronics, information processing, materials, and artificial intelligence), resulting in even more high-paying jobs, for which advanced degrees are not necessarily needed. Clearly, if Arizona wants to attract, retain, and grow successful biotechnology companies, it must invest not only in economic development and physical infrastructure but in its people as well.

REPORT

MARICOPA BIOINDUSTRY WORKFORCE COMMISSION

During the Summit, Dr. Anna Solley, Vice Chancellor of Academic Affairs for the Maricopa Community Colleges, announced the formation of the Maricopa Bioindustry Workforce Commission. Established to foster ongoing support of bioindustry at Maricopa, this initiative will also provide an overall coordination and a system-wide approach and perspective to the evolution and development of bioindustry and biotechnology-related programs and services within the ten colleges and two skill centers. Composed of representatives from community colleges, the district office, local universities, government, and the bioindustry, the Commission during its first phase will provide input and direction to the development and completion of a countywide needs assessment. The needs assessment will focus on the types of jobs projected for the Greater Phoenix area, the skills needed for such jobs, and an estimated timeline for the availability of these new jobs. In addition, based on the needs assessment, the Commission will establish a district-wide direction for bioindustry programs and related services.

During its second phase, the Commission will detail the flow of education and other program development, and explore related services, articulation efforts, career pathway programs, and math/science efforts that would serve as resources to the colleges. In addition, the Commission will serve as a district-wide external advisory committee and serve as the selection committee for faculty sabbaticals, student internships, and other benefits negotiated as part of the district affiliation agreement with TGen.

AN INVESTMENT IN INFRASTRUCTURE

Because the Arizona Department of Commerce believes biotechnology will continue to be an important industry of the future, Margie Emmermann reported that the state has committed \$90-100 million over five years to support the growth of the industry, a figure which is being matched by approximately \$125 million in private and other investments. This significant financial state commitment is seen as a wise investment that will be paid back in taxes alone. For example, it is estimated that the state support of bioindustry in Arizona will result in 300 science-based jobs, approximately 270 university researchers and others who will collaborate with these scientists, and a number of other personnel required to support these positions (e.g., in health-care, research, equipment design and sales, etc.). In addition, the state anticipates a minimum of two new start-up companies, with approximately





TRENDS IN BIOTECHNOLOGY

- Biotechnology is the fastest growing economic and fiscal sector of U.S. industry, having doubled between 1993 and 1999 to reach \$47 billion.
- Drug sales from August 1999-2000 equaled \$219 billion, with annual growth of drug therapies projected to be 8-10 percent through 2004.
- It is projected that bio-informatics alone will be a \$2 billion industry by 2005.
- According to Ernst and Young, the U.S. biotech industry has already created more than 437,000 jobs and had a \$47 billion dollar impact on the economy.
- In its report prepared for Arizona, the Battelle Memorial Institute estimates that Arizona's non-hospital biosciences industry employment can grow over the next decade from 9,100 jobs today to nearly 22,000 jobs by 2012. This includes over 10,000 jobs from the expansion of the existing bioscience firm employment base, with the remainder from new start-ups and relocations to the state. Battelle also predicts that the critical mass of bioscience firms will have a multiplier effect on other business service and supplier sectors of the economy, accounting for an estimated 17,000 additional jobs in all sectors of Arizona's economy.

80 new employees, bringing the total employment to 650 high-tech, high-paying jobs. Thus, the \$225 million invested will result in \$276 million in indirect economic development in the state and 650 employees earning an average salary of \$80,000, resulting in \$52 million in state incomes taxes by the year 2007.

To accommodate this growth, Sheryl Sculley noted that the City of Phoenix has made its own commitment to establishing the city as a major center for biotechnology. This commitment is, in part, the result of the city evaluating its economic base, and realizing that, in the long term, it needs to develop a more diversified economy and support industries that bring high wage jobs and new growth opportunities to the city. In addition, the City wants to revitalize the downtown area, bring more diversity into the city center, and develop a university and college presence as part of its new development activities.

The City of Phoenix considers itself a full partner in the state's efforts to develop a thriving biotechnology industry and is providing a 13-acre site in downtown Phoenix, to be developed as a biomedical research campus. In addition, another 10+ adjoining acres are available for growth. The site also includes three national historic buildings, totaling 65,000 square feet that will eventually be developed for adaptive reuse.

The City has completed a land use plan for the site, which includes phasing in up to 1 million square feet of development (see **City of Phoenix Biomedical Research Campus Concept Map**). The goal is to have the first building completed by the fall of 2004. To support these efforts, the City will issue bonds in up to \$31 million for the design and construction of the first 100,000 square-foot, mid-rise (e.g., 4-8 stories) bioscience research building. To ensure that the facility is completed on time and under budget, the City has hired a biomedical technical consultant and is also providing up to \$12 million for initial operation expenses for IGC/TGen.



City of Phoenix Biomedical Research Campus Concept Map: *The City has completed a land use plan for the site, which includes phasing in up to 1 million square feet of development.*





BIO-OPPORTUNITIES FOR COMMUNITY COLLEGES AND THEIR STUDENTS

“Like any knowledge-based industry, bioscience companies need a supply of qualified, trained workers. To meet the demands of newly emerging fields, new curricula and programs need to be developed by educational institutions working in close partnership with the bioscience industry.”

— Platform for Progress: Arizona’s
Bioscience Roadmap (2002)

With the new bioscience building and research campus moving toward construction, two speakers discussed the opportunities and challenges facing community colleges and their graduates. Michael Berens is the Interim Executive Director of TGen and the Co-Chairman of the Arizona BioIndustry Cluster, Inc., the group that spearheaded the state’s efforts to lure the International Genomics Consortium to Phoenix. Elaine Johnson is the director of Bio-Link, a National Science Foundation (NSF)-funded program that helps community colleges establish high-quality educational programs and provides support to community college faculty to ensure that their students are competitive in a rapidly changing industry. Both emphasized the possibilities presented by the growth of bioindustry in Arizona and provided advice on what kinds of education and training experiences bioscience and biotechnology companies most often require for entry-level and other positions in the industry.

AN INVESTMENT IN PEOPLE

Community college students with an interest in science, mathematics, and technology face a whole new world in bioindustry. Dr. Berens noted that in medicine alone biotechnology and bioscience can lead to new diagnostic tests, new treatments, new cures, and other new technologies designed to improve the quality of life. Clearly, bioscience/biotechnology is the industry of the future, Dr. Berens said, but it is a difficult one for researchers and faculty to prepare for, because it is developing so rapidly. He pointed to laboratory equipment as an example. By the time new equipment is ordered, shipped, and installed, some of it may already be out of date.

“Community colleges interested in preparing their students for jobs in bioscience, biotechnology, and computational biology need to be nimble and responsive to the changes in this dynamic industry,” Dr. Berens advised. Rather than invest in large programs, new laboratory equipment, and high-powered computers, he recommended instead that community colleges focus on building strength in the core programs of science, mathematics, and technology and make its major investment not in the physical infrastructure of the college but in its faculty who can then partner with TGen and others who join the cluster of research-based facilities projected for the Phoenix biomedical research campus.

While the state’s three universities work to attract top research scientists, the Maricopa Community Colleges will train the people who will work for them. To this end, Dr. Berens suggested that community college faculty spend summers and/or part of the academic year working in TGen labs, learning the latest processes and techniques that could then be shared with their students. Community college students could also work in TGen and other research labs as a way to train for careers in bioscience and biotechnology. In both examples, faculty and students would have access to cutting-edge equipment and laboratories that an individual community college would not be able to replicate. With these kinds of hands-on, state-of-the-art work experiences, coupled with a sound background in science, mathematics, and technology, community college students would be well qualified for the host of new job opportunities expected to result from new research-based biotechnology companies.





BIOSCIENCE AND BIOTECHNOLOGY: AN OLD IDEA THAT'S NEW

In the opening of her presentation, Elaine Johnson provided a quick overview of the history of bioscience and biotechnology. To illustrate the fact that the use of living organisms to produce products is not new, Dr. Johnson pointed to the first known use of biological processes to make leavened bread, beer, and yogurt. More recent applications of biotechnology and bioscience include the development of frost-resistant strawberries, and perhaps most famously, the cloning of Dolly, the sheep.

Other uses of living organisms, or their sub-cellular components that Dr. Johnson discussed, include stem cell research, tissue engineering, new drugs and disease treatments, biofuels development, and even DNA forensics. Products that have resulted from this newer research include biomaterials that can be used for wound healing and tissue engineering, and functional foods that are higher in vitamins, resistant to spoilage and/or environmentally tolerant to drought or frost. And, she noted, new advances in both bio-products and services are reported on an almost daily basis.

Because biotechnology is a collection of so many different industries, including everything from agriculture, to pharmaceutical, to environmental, to forensics, jobs are available for individuals with various skills and educational backgrounds. Many opportunities exist for two-year college graduates in biotechnology, Dr. Johnson noted, as long as those graduates are provided with an adequate academic background and opportunities to develop much needed skills. Specific jobs currently available in the field of biotechnology include research and development, production and quality control, sales and marketing, regulatory affairs, legal affairs, bioinformatics, materials science, public relations, communications, training, and human resources.

According to Dr. Johnson, bioindustry is hiring employees with strong backgrounds in biology, microbiology, chemistry, and technology, as well as those with strong and often sophisticated technical skills that can be applied to a variety of different work environments. These include basic lab techniques, safety skills, quality control skills, and instrument analysis skills. More sophisticated skills include cell culturing, DNA sequencing, column chromatography, sampling and documentation, and clean room techniques. General workplace skills are also essential, she noted. These include basic communication skills, mathematical and statistical skills, computer skills, interpersonal skills, and documentation skills.



Biotechnology and bioscience companies are also looking for future employees who can demonstrate a good understanding of sampling techniques, the use of systems approaches, and the ability to work as members of cross-disciplinary teams to solve specific problems. She mentioned that computer science and information technology are also gaining in importance, as the field of bioinformatics continues to grow. Bioinformatics uses computational approaches to answer biological questions, and through analyzing databases and identifying trends in the data, it often leads to significant scientific breakthroughs.

And new employees must be flexible. Dr. Johnson predicts that bioindustry will not be limited to current technologies but will explore new and even more exciting areas as new knowledge, techniques, and processes are developed. She also predicts that new breakthroughs will come from the integration of more traditional “wet biology” and newer analysis techniques being made possible by “digital biology.”

Dr. Berens agreed that employment opportunities will be endless. He listed the following technical positions as examples:

Molecular Biologists: Responsible for supporting core laboratory operations for gene expression profiling; requires background in molecular biology techniques, including fluorescence labeling and DNA:DNA hybridization.

Computational Biologist/Bioinformatician: Responsible for data entry, computer programming, software design, multidimensional scaling algorithms; must be familiar with Oracle database and have experience working with high powered computers.

Histology Technician: Supports core laboratory for gene validation in human disease tissues; experience in routine histological staining, immunohistochemistry, image analysis, immunofluorescence, and in situ hybridization.

Animal Research Technician: Supports research in new therapies against cancer and autoimmune diseases; requires familiarity with humane and ethical treatment of small animals in research environments, tumor measurements, data recording, reporting, and analysis.

Clinical Research Coordinator: Works with patients in large clinical trials; requires experience working with patient data recording and reporting to database, travel for re-certification, and excellent administrative and people skills.

Medicinal Chemist Technician: Works with pharmaceutical venture; requires familiarity with GLP operations, data document filing for FDA certification, inventory control, and quality control/quality assurance operations; strong background in organic chemistry also required.

Dr. Berens explained that these kinds of technical positions, and others that are expected to result from new biotechnology research and start-up companies, will require a highly trained and up-to-date workforce. College graduates, even those with advanced degrees, may need to turn to the community colleges to learn new techniques and processes to help make them more competitive in this new job market. Again, “the secret is for community colleges to be nimble and forward looking and to invest in college faculty who can then, in turn, stay abreast of new knowledge and technologies.”

WHERE THE JOBS WILL BE

Like many high-tech industries, biotechnology and bioscience companies tend to cluster in areas where they can locate next to similar businesses, find both research and educational support, and have access to a qualified workforce. Dr. Johnson shared a map of the United States that graphically illustrated this point. While the map documents a large number of companies clustered along the west and east coasts and in Texas, Dr. Johnson noted there is “a very vacant spot in Arizona.”

If Arizona is to successfully fill that blank spot on the map and attract biotechnology and bioscience companies to the state, community colleges need to focus their activities to help meet the educational and workforce needs of this new industry. Community colleges are well suited to meet these needs, Dr. Johnson noted, because they are much more flexible when it comes to responding to the needs of their community and have a national reputation for developing excellent academic programs to meet the needs of diverse populations. They are, therefore, able to relatively quickly adapt their programs to meet different workforce needs.



**UNITED STATES
PUBLIC BIOTECH COMPANIES**



Bioindustry tends to cluster near similar businesses. Bio-Link has worked with the community colleges and biotechnology/bioscience companies in these regional clusters to develop local educational leadership and to ensure that new educational programs are developed to meet the industry's growing workforce needs.

BIOTECH



STAYING OPEN TO CHANGE

If there was one consensus from the entire meeting, it was that bioindustry means change. For that reason, Dr. Johnson advised community colleges that they, too, must stay open to change. To this end, she recommended that colleges develop programs that:

- complement a student's academic background with hands-on skills development;
- break down the barriers between disciplines so that students understand, and can work in the new cross disciplinary research environment, and
- move students whenever possible out of the traditional classroom and into laboratories and industrial internships where they have the real-world opportunities they need to learn.

In the wrap up to the first half of the meeting, the presenters all agreed that the opportunities for



the next generation of students will be endless if they are given access to the kinds of educational opportunities they will need to be successful in today's — and tomorrow's — workplace. To be successful in this industry will not require a Ph.D.; however, future employees will

need to develop a variety of skills and backgrounds if they are to compete. To develop a workforce with these kinds of skills and education requires partnerships at all levels — from grade school to high school, to college and university, as well as with research labs and private companies. It also requires that all partners have respect for the individual contributions that each makes to such an enterprise, and to appreciate the partnerships for what they truly are: an investment in Arizona's future.

...future employees will need to develop a variety of skills and backgrounds if they are to compete.

BIO-LINK NATIONAL CENTER
City College of San Francisco
Director: Elaine Johnson, Ph.D.

Bioindustry is one of the fastest growing sectors in the U.S. and has already created 150,000 new jobs nationwide. In recognition of this growth, the National Science Foundation funded the Bio-Link program at City College of San Francisco in 1998, to work in partnership with industry and community colleges nationwide to increase the number and diversity of well-trained technicians in the biotechnology workforce. Bio-Link helps community colleges establish high-quality educational programs and provides support to community college faculty to ensure that their students are competitive.

Because bioindustry is rapidly changing and broad in scope, the workforce needs of industry are equally broad and subject to change. For that reason, Bio-Link has established several regions around the country to work with local biotech companies to ensure that the programs developed by community colleges are not generic but are designed to meet the changing needs of the companies in those regions. The Bio-Link National Center is at City College of San Francisco with office space at the University of California San Francisco. Regional Bio-Link Centers across the country are located in Seattle, WA; San Diego, CA; San Francisco, CA; Austin, TX; Madison, WI; Graham, NC; and Portsmouth, NH.

The goals of Bio-Link include supporting a cadre of well-trained instructors, increasing the number and quality of biotechnology programs for students, and bringing a wide range of underrepresented students to biotechnology, who have the knowledge and skills essential to the field, as well as the ability to continue with more advanced education in math, science, and engineering. Bio-Link supports a Clearinghouse of Instructional Materials for Biotechnology Technician Education — a collection of instructional and curriculum materials that are specifically targeted for courses and programs that educate biotechnology technicians and bench scientists. These include curriculum materials (e.g., skill standards, course descriptions, course competencies, etc.); laboratory exercises; classroom activities; reviews of relevant published materials and/or web sites; assessment tools; information on courses available on-line at community colleges nationwide; and links to other related sites. All materials and resources are available at no charge to community colleges.

Bio-Link Director, Elaine Johnson, earned her Ph.D. at the University of Texas at Austin. She is a Faculty Fellow at Lawrence Berkeley National Laboratory and has participated in the development of the National Skill Standards for Bioscience and their integration with the Agricultural Biotechnology Standards.

For more information:
<http://www.bio-link.org/>







NEXT STEPS FOR COMMUNITY COLLEGES

“The biosciences provide a way to build a stronger, more stable, and diversified Arizona economy, offering quality, well-paying jobs from technician to researcher.”

— **Platform for Progress: Arizona's
Bioscience Roadmap (2002)**

During the second half of the Bioindustry Workforce Summit, speakers presented background information on their biotechnology programs, and provided advice on the steps community colleges should take when developing biotechnology education and workforce training programs on their campuses. Speakers included Linnea Fletcher, Biotechnology Program Coordinator at Austin Community College in Texas, Wendie Johnston, Director of the Biological Technologies Program at Pasadena City College in Southern California, Jeffery O'Neal, Director of the Biotechnology Center at American River College in Sacramento, California, and Denise Clark, Director of the Biotechnology Program at Mesa Community College in Arizona.

The following is a synthesis of their collective advice, based on their experiences establishing programs that meet the needs of their students and local bioindustry. The Maricopa Community Colleges should use these recommendations as a starting point, when considering the development and enhancement of biotechnology programs, and then build on them as they develop campus-specific education and training programs.

ON CAMPUS

— **Form a Team**

Planning, developing, and implementing a new program in biotechnology cannot be done alone, advised Denise Clark from Mesa Community College. Since faculty develop new courses all the time, it is easy to assume that they have the necessary background needed to develop a new program in biotechnology. But training students to be competitive in the biotechnology industry is not the same as preparing them to work in research labs, where most faculty receive their training, Dr. Clark cautioned. Instead of working on their own, faculty need to enlist administrative support from the very beginning, and put together a cross-disciplinary team of faculty, administrators, researchers, and industry representatives to help plan and develop the new program. And the team should plan in advance, she advised. A new program needs to be well thought

out before it is implemented and not developed semester by semester.

— **Involve Everyone From the Very Beginning**

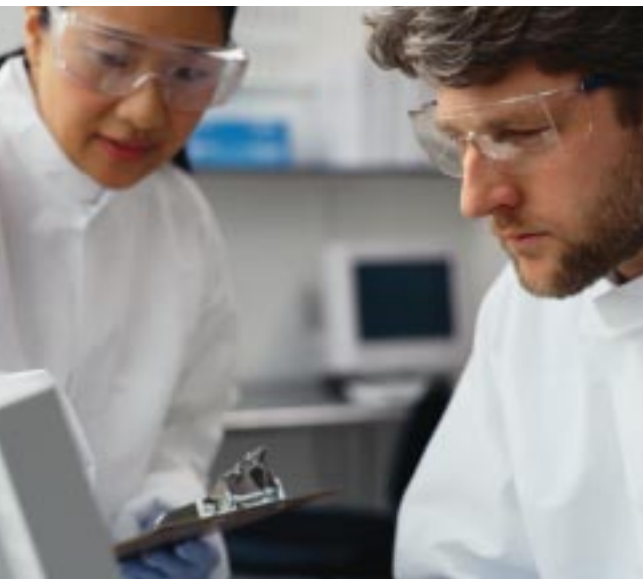
If a program is to be successful, all stakeholders should be kept informed from the very beginning. Faculty, administrators, and industry representatives need to be involved, but it is important to also involve campus staff members, parent groups, and community leaders. For example, orientation sessions can help prepare staff to respond to questions as they arise, and outreach and community-based education programs can help parents and community members be more knowledgeable about the issues affecting biotechnology. Outreach to the community and parents is particularly important when serving communities with large Hispanic populations. Linnea Fletcher has developed recruitment films for the Austin Community College Biotechnology Program, designed specifically to target parents and students, while also educating viewers about biotechnology. Dr. Fletcher also recommended developing good relationships with science and mathematics teachers at the K-12 level to ensure strong preparation of prospective students.

— **Provide On-Going Professional
Development Opportunities for Faculty**

Faculty should have an opportunity to actually do the work that their students will be doing so that they can better understand what industry needs in their employees. For that reason, Linnea Fletcher and Wendie Johnston both recommended that community college faculty be given leaves of absence so that they can work in local companies and learn new techniques and processes. Most importantly, faculty will have a better appreciation for the kind of work their students will be doing. These are not, for the most part, boring jobs; rather, these jobs can be very creative and rewarding for the right employee, Dr. Fletcher said.

— **Go Electronic Whenever Possible**

Wendie Johnston noted that planning is time consuming, but much of the initial planning for new programs could be done electronically, using e-mail and/or web sites thereby avoiding lengthy meetings. When real-time meetings are necessary, be sure faculty have been provided with training in meeting facilitation. This will help make everyone more productive and the meetings more action-oriented.



*Because they work so
closely with industry,
the students are trained
exactly as industry
needs them...*

BIOTECHNOLOGY PROGRAM Austin Community College Program Coordinator: Linnea Fletcher, Ph.D.

The Austin Community College Biotechnology Program was conceived in 1997 and enrolled its first students in the fall of 1999. ACC offers a curriculum of specialized courses, designed to provide students with the basic skills and state-of-the-art techniques they will need to meet the growing need for trained technicians in Central Texas's bioscience and biotechnology industries. Courses are taught both by expert academics and



industry professionals, who helped develop the program curriculum. Because they work so closely with industry, the students are trained exactly as industry needs them, and before the students graduate from the program, most of them are hired by industry. The program

refers to these students as "successful non-completers."

ACC offers both AAS degrees and certificates in biotechnology and prepares students for transferring to 4-year colleges. ACC also offers continuing education for working professionals in the biotech industry and has established strong outreach programs at K-12 schools, with professional development programs available for their teachers. In addition, ACC serves as a regional center for the NSF-funded ATE (Advanced Technology Education) center grant, Bio-Link.

Linnea Fletcher earned her Ph.D. in Microbiology at the University of Texas at Austin. After working for several years in laboratories, she joined the faculty at Austin Community College, where she helped to develop the biotechnology program. Dr. Fletcher is also the Regional Director of the South Central Region of Bio-Link and is currently working on the development of an Introduction to Biotechnology course to be offered in local high schools.

For more information:

<http://www2.austincc.edu/biotech/acc>

STUDENT OUTREACH

— Start Recruiting Students Early in the Process

Linnea Fletcher, Denise Clark, and Wendie Johnston all emphasized the importance of having someone actively recruiting students to ensure that there are students ready by the time the program and/or courses are available. Recruitment and marketing kits (e.g., posters and eye-catching brochures) can help facilitate the process. Dr. Fletcher recommended that students be recruited at least

two years in advance, with outreach programs to the high schools, as well as to campus programs in chemistry, biology, and other relevant disciplines. Dr. Clark recommended developing a detailed marketing strategy, which includes reaching out to local K-12 schools, so that students are in the pipeline from the very beginning. Additionally, Dr. Fletcher emphasized the importance of reaching out to students who might not have an initial interest in science or be considered academically prepared to excel in science. Surprisingly, she has found that it is not those who are strong in science, but often those with an interest in hands-on learning, who are best equipped to excel in technician types of jobs. Elaine Johnson also emphasized the importance of recruiting students already on campus — a pool often overlooked by student recruiters.

— Develop 2+2+2 Programs

Programs that encourage students to move from high school (junior and senior years) to community colleges (two years) to four-year colleges and universities (final two years) in a “seamless” progression, have proven to be very successful, because students are better prepared for learning new technologies if they are introduced to them early in their academic careers, preferably in high school.



For example, Pasadena City College offers a 2+2+2 program in computational biology, ensuring that students receive the necessary mathematics and technology background in high school and at the community college, so that they are well prepared for completing their B.A. once they transfer to a four-year program. According to Wendie Johnston, paid summer internships are also available for community college students at UCLA. Similarly, Jeffery O’Neal stated that at American River College in Sacramento, students can transfer to the University of California to pursue a degree in biotechnology, or to California State University, where they can continue on through a master’s degree in applied biotechnology. For these kinds of programs to be successful, community colleges need to develop strong, working relationships with local high schools and four-year colleges and universities to ensure that all students have the appropriate academic background and are developing the necessary skills they will need to effectively transfer, should they decide to pursue four-year or advanced degrees.



— Provide Educational Opportunities for Families and Community Leaders

At American River College in Sacramento the course “Biotechnology and Society” provides an overview of biotechnology and is offered online and at local high schools. Likewise, Mesa Community College also offers a course in Biotechnology and Society. According to Jeffery O’Neal and Denise Clark, these survey-like courses provide opportunities for the students and the community to learn about biotechnology, understand current events, and gain a better appreciation of how biotechnology impacts society.

In addition, Dr. Johnston recommended developing on-campus workshops for high school science teachers so that they are better prepared to introduce new concepts and technologies in their classrooms.



BIOLOGICAL TECHNOLOGIES PROGRAM

Pasadena City College
**Director: Wendie Anne
Johnston, Ph.D.**

Pasadena City College offers a Biological Technologies Certificate Program designed to prepare students for entering the full-time biotechnology industry workforce, be competitive for research jobs while at four-year institutions, and qualify for high-paying part-time work while finishing a college degree. The program takes an interdisciplinary approach, with courses and practical training in math, chemistry, biology, computer skills, and English. This program also includes practical laboratory skills combined with training in quality assurance and quality control in a working laboratory setting, along with supervised work experiences in the biotech industry. Students are kept abreast of current advances in biotechnology by speakers from industry, internet assignments, and tours of local biotech facilities.

The program's Lab Skills courses are run in a manner that closely simulates the work environment in the biotech industry, including the use of OSHA (Occupational Safety and Health Administration) standards and FDA (Food and Drug Administration) Good Laboratory Practices standards. Production runs are scheduled to supply materials for courses in the Biology Department. Quality control is maintained, and documentation is kept in a manner appropriate to industry formats. Assessment of skills is continuous. A one-hour "staff meeting" is held weekly for scheduling and for introduction of new skills. Each student learns to function as a project manager and participate in the evaluation process. Performance evaluations are held twice each semester and consist of notebook evaluation, resume evaluation, and a skills evaluation.

Director, Wendie Anne Johnston, earned her Ph.D. from UCLA, specializing in Cell Physiology. To prepare for establishing the Regional Biotechnology Center at PCC, and to ensure the program reflected the needs of industry, she spent her sabbatical working with entry-level biotechnology workers in the Los Angeles Police Department Serology Lab (Los Angeles, CA); the National Wildlife Forensics Lab (Ashland, OR); Georgetown University (Washington, D.C.); Trevigen (Gaithersburg, MD); Huntington Memorial Research Institute (Pasadena, CA); CalGene (Davis, CA); and Stratagene, Inc. (La Jolla, CA).

For more information:

<http://www.paccd.cc.ca.us/biotech>



INDUSTRY PARTNERSHIPS

— Conduct a Needs Assessment of Local Industry

All speakers agreed that community colleges must conduct detailed needs assessments of local employers if the goal is to develop a successful and relevant biotechnology program. According to Jeffery O’Neal, such a survey should not only include detailed questionnaires and/or interviews but should also include site visits so that faculty and others involved with curriculum development have a better understanding of what they are educating students to be able to do.

— Recruit Potential Employers to Serve on Advisory Board

When establishing new biotechnology programs designed to develop a skilled and competitive workforce, it is critical that representatives from local companies serve in some advisory capacity, all agreed. And all types of companies, industries, and organizations should be considered, according to Linnea Fletcher, to ensure that the skills being developed in educational and training programs are designed to meet the widest possible spectrum of potential jobs. As examples, Dr. Fletcher pointed to research and medical companies, government agencies, which might have a need for employees with strength in biotechnology/bioscience (e.g., the Center for Disease Control, regulatory agencies, etc.), and even universities, which often hire technicians to work in research and other labs.

— Line Up Financial and Other Support Early in the Process

For biotechnology programs to succeed at a community college, faculty will need access to facilities and equipment that can be extremely expensive to purchase. As noted by Dr. Berens and others, access to equipment can come from developing partnerships with industry, which will have state-of-the-art laboratory facilities; other equipment and facilities can often be arranged by sharing lab space with existing biology and chemistry labs. Dr. Fletcher has arranged for local companies to provide adjunct faculty to teach in the program, in exchange for allowing new employees to attend the biotech training courses for free. This way her students have access to equipment, and the adjunct faculty help keep the curriculum current.

THE NORTH VALLEY AND MOUNTAIN BIOTECHNOLOGY CENTER American River College Director: Jeffery O’Neal

The Greater Sacramento area, in which American River College (ARC) is located, is home to more than 25 biotechnology companies, many of them focused on agriculture. The nearby University of California - Davis is a major agricultural and medical biotechnology research university, with over 270 faculty members engaged in biotechnology-related research.

The North Valley and Mountain Biotechnology Center at ARC, founded in 1998, trains and builds a highly motivated and qualified workforce for the rapidly expanding biotechnology industry. American River College offers individual courses in biotechnology, as well as a Certificate and Associate of Science Degree Program, with some courses offered online. Courses include Introduction to Biotechnology, Biotechnology Methods, PCR Methods, Biotechnology Work Experience, and Biotechnology and Society. In addition, both



work experiences and internships are available, with the goal of providing both a solid grounding in theory, as well as hands-on lab

skills. While in the program, students learn the underlying theories and principles of biotechnology as well as current applications in areas such as agriculture, medicine, forensics, and diagnostics. Ethics are covered, as well as other topics including employment opportunities and social implications of critical advances. Students are prepared both for entry into the biotechnology industry and/or entry into four-year biotechnology programs.

Director Jeffery O’Neal is a molecular biologist with more than 20 years’ experience in university and industrial research — work that led to both U.S. and international patents on biotechnology products. As coordinator of the University Extension Biotechnology Program at UC Davis, he promoted the need for access to quality biotechnology education. He has been director of the NV&MBC since 1998.

For more information:
<http://www.arc.losrios.edu/~biotech>



CURRICULUM DEVELOPMENT

— Determine Your Campus' Unique Niche

All of the speakers noted the importance of defining a specific area of strength at a particular campus and building on that strength, rather than trying to be all things to all people in biotechnology. For example, at American River College, where many local biotechnology companies focus on agriculture, the College offers courses in the science and principles of biotechnology, as well as courses that develop skills in current applications in agriculture and medicine. At Mesa Community College, the emphasis is on biomedical training. Targeting a specific area of biotechnology also allows for a campus to hire specific expertise that complements existing faculty and to focus its equipment on specific areas. It also prevents campuses in the same area from competing for students and resources.

— Determine Needed Competencies

There are certain competencies employees need if they are to be successful in biotechnology jobs. It is therefore critical that faculty meet with representatives from the biotechnology industry, including government labs and universities, to define those competencies and then to design programs that meet those competencies. For example, Dr. Fletcher obtained a list from Bio-Link of all competencies considered important in the biotechnology industry and worked with local industry to fine-tune that list to meet local needs. She then established a one-year certification program for entry-level employees, as well as a two-year degree program. She also decided on a night program to meet the needs of existing employees. Dr. Fletcher also recommends meeting with representatives from local biotech employers annually, because the needs of industry rapidly change.

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— Look Beyond Science when Developing Curriculum

When Wendie Johnston wanted to design a new program in molecular biology at Pasadena City College to help train students for the local biotechnology industry, she took time off to work in a variety of companies so that she would have hands-on experience with what it is like to work in them. As a result of her experience, she recommends that the curriculum be developed to minimize the classroom and duplicate the work environment as much as possible. For example, she offers her biotechnology-related courses in a dedicated laboratory, with students treated like employees who develop “products” for a variety of clients. Students must maintain inventories and project potential shortages. Even the students’ notebooks, which must be kept to industry standards, cannot leave the labs, to better replicate the experience of working for a private company. She also believes that articulation and certificates are less important than documented skills. Regardless of a student’s long-term plans, Dr. Johnston recommends that students learn how to develop a skills-based resume, so that they start documenting their skills as they are developed.

PARTING ADVICE

— Be Flexible

When designing new curriculum, look at different ways to achieve your goals. For example at American River College, biotechnology is offered as a capstone experience. Courses include Introduction to Biotechnology, which includes lab and lecture time, and Methods in Biotechnology. As a capstone experience for students, these courses are designed to complement and build upon their previous coursework. ARC has also developed elective short courses to meet specific needs for skill development.

— Make Realistic Projections

Employment projections are difficult to make, so program developers should try to be as realistic as possible. All speakers reported being able to place all students who were interested in finding employment, but it is important that the program not grow faster than possible job openings in the area, they cautioned.

BIOTECHNOLOGY PROGRAM Mesa Community College Director: T. Denise Clark, Ph.D.

Mesa Community College is currently the only two-year college in Arizona offering a biotechnology degree program. The Biotechnology Associate in Applied Science degree program prepares students for careers as technical assistants in federal, state, and local government laboratories, biomedical, pharmaceutical, and bioengineering laboratories, agriculture and horticulture, microbiology, environmental, and academic laboratories.

In addition to seminars in biomedical applications, laboratory protocols, current topics in agriculture, and ethical and moral issues, all of which address current topics in biotechnology,



and core courses in microbiology, human genetics, cellular/molecular biology, and chemistry, the program includes hands-on experience in the laboratory followed by an internship to provide students with a working knowledge of the field.

Mesa also offers a Biotechnology Certificate of Completion that provides students with hands-on experience in the laboratory followed by an internship.

The director of the program, T. Denise Clark, earned her Ph.D. in Biochemistry and Molecular Biology at Virginia Polytechnic Institute and State University. She conducted post-doctoral training at the Massachusetts Institute of Technology, the U.S. Department of Agriculture, and the AMC Cancer Research Center. Before moving to Mesa to start up the biotechnology program in 1999, she taught at the University of Alaska, Anchorage, and at the Metropolitan State College of Denver.

For more information:

<http://www.mc.maricopa.edu/~tdclark/biotechnology>





THE FUTURE IS NOW

“Arizona cannot stand still and remain economically viable while other states make key investments in their future around the biosciences. The key to [the state’s success] is sound execution that requires talent, commitment, and perseverance. Strategies can be successful only if implementation is achieved.”

— Platform for Progress: Arizona’s
Bioscience Roadmap (2002)

During the wrap-up session, Gene Giovannini, President of GateWay Community College, Bryan Tippet, Dean of Instruction at Estrella Mountain Community College, and Stephen Williams, Chair of the Department of Biology at Glendale Community College, briefly discussed the future of bioindustry and the future of Maricopa Community Colleges. In general, all were optimistic that the Maricopa colleges can meet the challenges ahead and that faculty and administrators will develop innovative and effective programs to meet the exciting opportunities inherent in bioindustry.

Dr. Giovannini predicted that bioindustry will be bigger than the current revolution in information technology, further stating that bioscience and biotechnology will affect all of society. Clearly, the Maricopa Community Colleges need to be prepared for this change if their students are to continue to be competitive, he said. But as both Dr. Giovannini and Dr. Tippet pointed out, to compete in this industry, students will need strong backgrounds in science, mathematics, and technology areas. Fortunately, these are where the Maricopa colleges are already strong.

Dr. Tippet noted that the growth in biotechnology provides Maricopa colleges with opportunities to innovate when developing new curriculum, but it also poses challenges to strengthen their basic programs in science, mathematics, and technology.

In fact, he said, it will be more important than ever to look for ways to merge science, mathematics, and technology, to better replicate how science is actually done in the workplace.

Faculty at all the campuses will have many levels of experience to bring to the development of these new programs, according to Dr. Williams. And, as Dr. Tippet added, faculty will also need new opportunities for professional development opportunities to stay abreast of the latest techniques. To this end, Dr. Tippet emphasized the importance of partnerships with both industry and state universities to ensure that all Maricopa students are competitive and prepared for work in the lab. Partnerships with colleges and universities will also be important to ensure smooth articulation for students desiring four-year degrees, Dr. Williams said.

To be most effective, Maricopa colleges should build on their existing strengths, Dr. Giovannini advised, while considering the development of new degree programs and new continuing education programs to meet the needs of those already employed. But as Dr. Williams cautioned, no one will benefit from the development of ten different programs at each of the ten community colleges. For that reason, it will be critical for faculty and administrators at all campuses to communicate regularly and work to identify their strengths when developing new programs. To this end, Dr. Giovannini suggested that the group host a cross-disciplinary conference to examine ways faculty and their students can become involved in biotechnology and bioscience education and research.

Biotechnology and bioscience may be the industries of the future, but in summary, they all agreed that the future of bioindustry at the Maricopa Community Colleges is here now.



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OCTOBER 11, 2002

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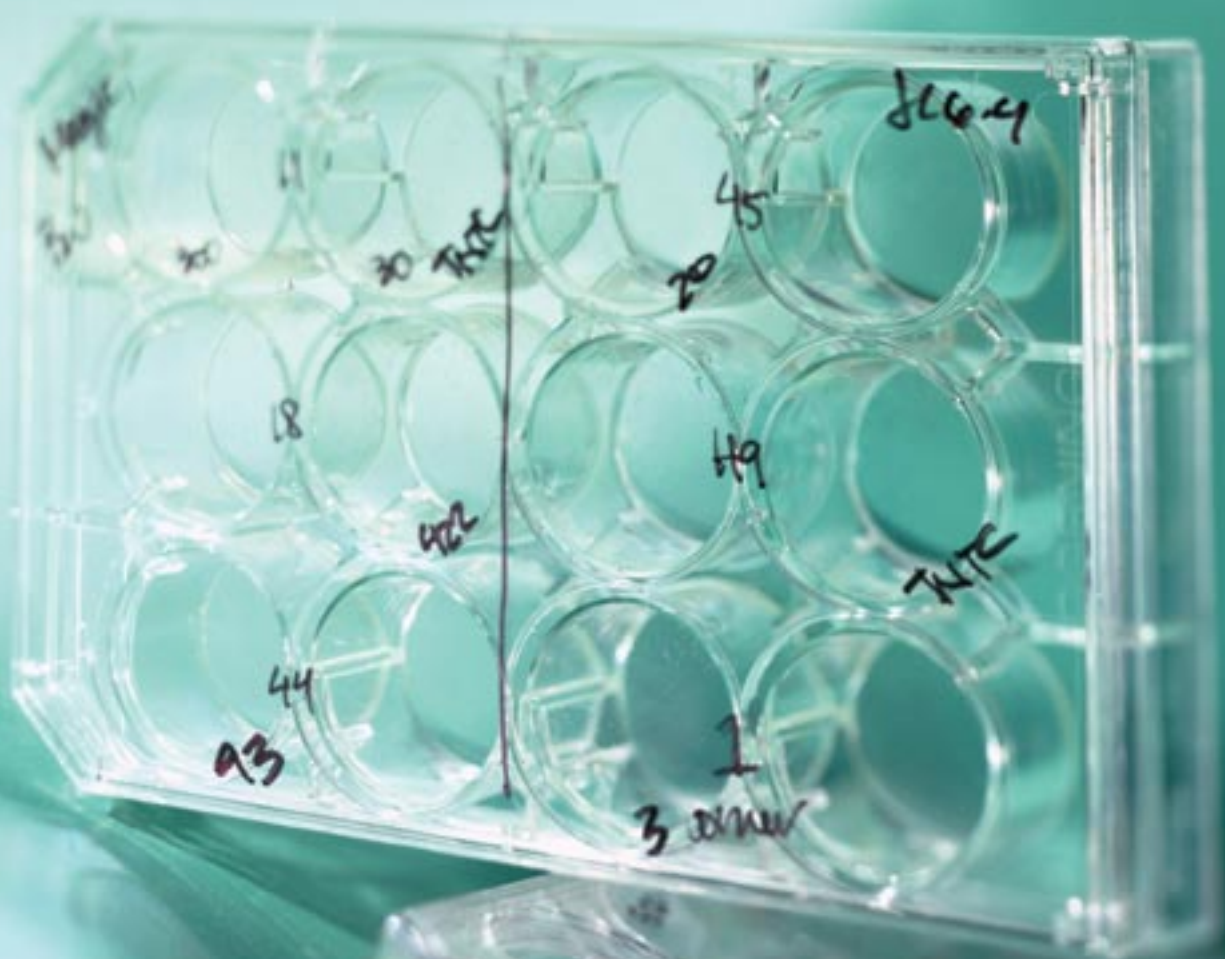
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A Community of Colleges...A World of Opportunity

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Estrella Mountain Community College

GateWay Community College

Glendale Community College

Mesa Community College

Paradise Valley Community College

Phoenix College

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Maricopa Skill Center

SouthWest Skill Center

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